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Epidemiology of Parasitic Infections in the West Bank and Gaza Strip, Palestine

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Abstract. Parasitic infections are a public health problem that affects all population levels in developing countries including Palestine. The current study describes the epidemiology of parasitic infections in Palestine from 2008 to 2017. Twelve prominent parasitic infections were reported: leishmaniasis (both cutaneous and visceral), malaria, hydatid disease caused by hydatid cysts, toxoplasmosis, ascariasis, oxyuriasis, strongyloidiasis, taeniasis caused by *Taenia saginata*, amebiasis, giardiasis, and scabies. A total of 137,106 cases were reported; among them, 92,494 (67%) in the Gaza Strip and 44,612 (33%) in the West Bank. This study provides baseline information for better understanding the status of parasitic infections in Palestine and compares their epidemiology between the West Bank and Gaza Strip. Appropriate control measures and health education directed to the public about preventive measures should be considered to raise awareness about parasitic infections to lower their incidences and burden in Palestine.

INTRODUCTION

Parasitic infections are a major public health concern in developing countries. Displacement of people due to conflicts and wars, international travel, and shifting patterns of immigration has increased the importance of raising awareness of these infections. The WHO estimated the global burden of parasitic infections at approximately three billion reported cases and one million deaths per year.[1–3]

Because of their varied life cycles, parasitic infections are known to be associated with geographic and socioeconomic factors, as well as natural disasters and wars, poverty, malnutrition, personal and community hygiene, high population density, unavailability of clean water, low health status, and absence of or poor sanitation. All these conditions enhance the growth, transmission, and dissemination of parasites and increase disease incidence.[4–6]

In Palestine, like other developing countries, parasitic infections are considered a neglected health problem, and they are among the leading causes of morbidity in Palestinian society. According to the Palestinian Ministry of Health, thousands of Palestinians have been exposed to parasites and thousands of them become ill from these infections.[7,8]

In the Gaza Strip, intestinal parasitic diseases have been endemic for a long time; the most common infections include nematodes (*Ascaris lumbricoides*, *Enterobius vermicularis*, *Strongyloides stercoralis*, and *Trichuris trichiura*), cestodes (*Hymenolepis nana*), and protozoa (*Entamoeba histolytica/dispar*, *Giardia lamblia*, and *Cryptosporidium parvum*).[9]

These pathogens can cause potentially serious diseases and may be fatal if left untreated, especially in children and the elderly.

In the West Bank, few studies have been carried out on gastrointestinal parasites, and no countrywide comprehensive studies on the most common parasitic infections have been conducted so far.[9–14] Intestinal parasitic infection is still a problem in Palestine, probably because of weak health status, poor sanitation, population crowdedness, mainly in Palestinian refugee camps, bad hygienic habits, and poor health awareness. The main objective of this study was to investigate the epidemiology of parasitic infections reported by the Palestinian Ministry of Health between 2008 and 2017 in the West Bank and Gaza Strip.

MATERIALS AND METHODS

Study area. Palestine is located in the Middle East with two unconnected geographical areas, the West Bank and Gaza Strip. The West Bank consists of the following districts: Hebron, South Hebron, Bethlehem, Jerusalem, Ramallah, Jericho, Nablus, Jenin, Tubas, Tulkarem, Qalqilya, and Salfit. The Gaza Strip has the following districts: North Gaza, Gaza City, Deir Al Balah, Khan Younis, and Rafah (see Figure 1). The total Palestinian population in 2017 was 4.95 million (three million in the West Bank and 1.95 million in Gaza Strip).[15] More than 66.2% of the Palestinian population in the Gaza Strip and 26.6% of the population in the West Bank are refugees living in crowded camps.

Data collection and analysis. Because many parasitic infections are reportable diseases, the Palestinian Ministry of Health annual statistical reports were screened for the years 2008 until 2017 (the latest published report). Information about the following diseases was collected: leishmaniasis, malaria, hydatid disease, toxoplasmosis, ascariasis, oxyuriasis, strongyloidiasis, taeniasis, amebiasis, giardiasis, and scabies. The data collected included the type of parasitic infection, number of cases, district, and date of infection.

For data analysis, the number of patients for each parasitic disease per year in each Palestinian district was determined. The average annual incidence rate/100,000 inhabitants was calculated for each district.

RESULTS

There were 12 prominent parasitic infections reported from 2008 to 2017 in Palestine: leishmaniasis (both cutaneous and visceral), malaria, hydatid disease caused by hydatid cysts, toxoplasmosis, ascariasis, oxyuriasis, strongyloidiasis, taeniasis caused by *Taenia saginata*, amebiasis, giardiasis, and scabies. The geographic distribution of cases in each district in the West Bank and Gaza Strip shows Gaza City, Nablus, North Gaza, Rafah, and Khan Younis with the highest number of cases, and Hebron with the lowest (Table 1, Figure 1). The highest number of reported cases of parasitic infections was

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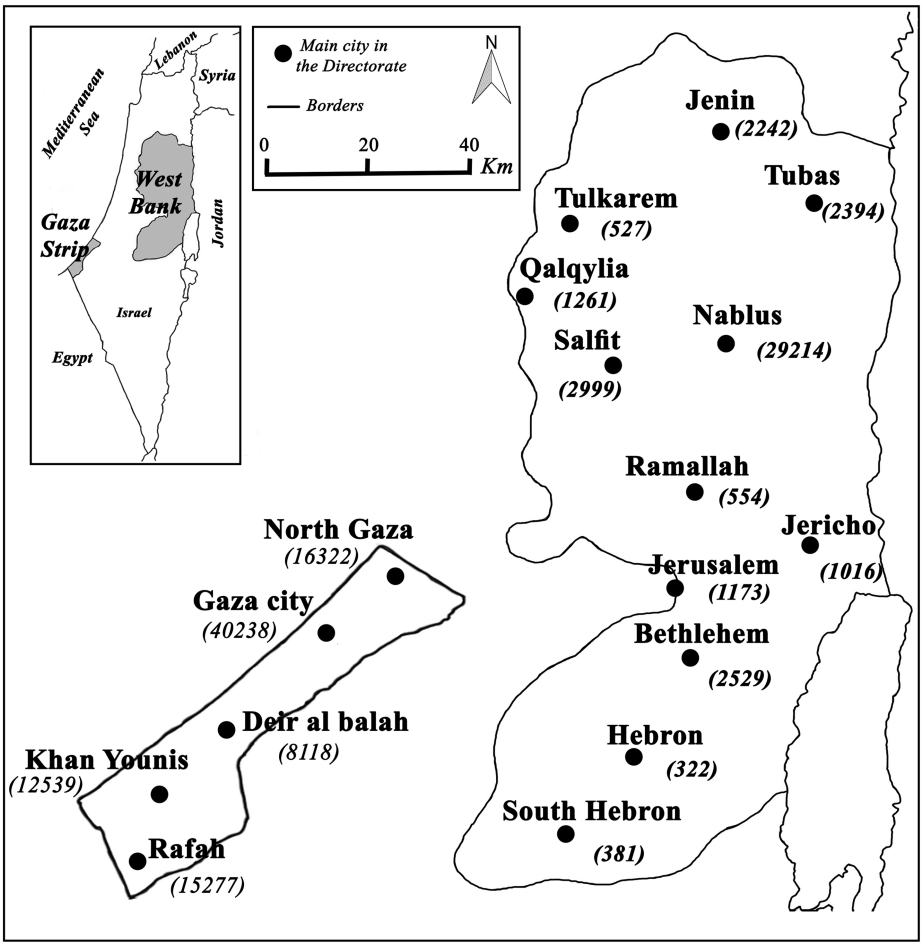

FIGURE 1. Map of the West Bank and Gaza Strip with geographical distribution of parasitic infections in each district with corresponding total number of cases from 2008 to 2017.

in 2008: 25,524 total cases, with 15,337 in the West Bank and 10,187 in the Gaza Strip.

The major parasitic infections reported were those caused by intestinal protozoans, with amebiasis caused by *E. histolytica* being the most common with 69,771 cases (6,638 in the West Bank and 63,133 in the Gaza Strip), followed by giardiasis with 23,062 cases (West Bank 61 and Gaza 22,801), strongyloidiasis with 729 cases (West Bank 667 and Gaza 261), and ascariasis

TABLE 1
Total numbers of cases in Palestine from 2008 to 2017 as reported by Palestinian Ministry of Health

	District	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total
Gaza	North Gaza	1,608	1,402	2,189	1,146	1,961	1,713	2,473	1,308	1,424	1,098	16,322
	Gaza City	4,220	3,435	4,790	2,582	5,517	4,344	4,664	3,198	3,723	3,765	40,238
	Deir Al Balah	1,240	1,039	1,046	614	1,207	662	974	470	426	440	8,118
	Khan Younis	1,425	861	1,219	691	1,418	1,293	2,101	1,296	1,253	982	12,539
	Rafah	1,694	1,780	1,681	935	1,947	1,939	1,928	1,193	1,139	1,041	15,277
	Total	10,187	8,517	10,925	5,968	12,050	9,951	12,140	7,465	7,965	7,326	92,494
West Bank	Hebron	80	14	22	8	11	10	36	57	54	30	322
	South Hebron		38	28	11	64	49	60	28	40	63	381
	Bethlehem	115	335	239	129	332	380	309	337	227	126	2,529
	Jerusalem	106	83	92	43	186	173	181	121	110	78	1,173
	Ramallah	4	60	84	48	122	49	64	43	55	25	554
	Jericho	65	126	123	61	91	53	107	221	112	57	1,016
	Nablus	14,069	2,270	2,246	722	2,228	2,497	2,207	1,206	1,073	696	29,214
	Jenin	148	1,092	234	121	155	113	43	249	26	61	2,242
	Tulkarem	29	63	28	27	75	58	99	56	48	44	527
	Qalqilya	49	219	89	30	69	179	136	150	137	203	1,261
	Salfit	672	402	272	67	61	384	377	270	237	257	2,999
	Tubas		54	45	50	321	571	498	385	245	225	2,394
	Total	15,337	4,756	3,502	1,317	3,715	4,516	4,117	3,123	2,364	1,865	44,612
	Total Palestine	25,524	13,273	14,427	7,285	15,765	14,467	16,257	10,588	10,329	9,191	137,106

with 3,465 cases (West Bank 1,947 and Gaza 1,518). Other parasitic infections reported were oxyuriasis with 28,245 cases (West Bank 27,924 and Gaza 321), leishmaniasis (reported in the West Bank only) with 2,712 cases (cutaneous: 2,672 and visceral: 40), scabies with 8,665 cases (West Bank 4,027 and Gaza 4,638), hydatid disease (in the West Bank only) with 401 cases, and toxoplasmosis with 47 cases (West Bank 27 and Gaza 20). Uncommon parasitic infections reported in the West Bank were seven malaria and two taeniasis (*T. saginata*) cases.

The yearly trend of the major parasitic infections in the studied period was similar in every year, except for oxyuriasis which had a remarkable peak in 2008 (Figure 2).

The total number of cases for amebiasis and giardiasis fluctuated, with the lowest number of reported cases in 2011 (4,453 and 8,227 cases, respectively), and the highest in 2010 (8,227 and 3,080 cases, respectively).

The lowest average annual incidence rate was found for taeniasis (0.01 cases/100,000 inhabitants in the West Bank). High average annual incidence rates were found for amebiasis (164 cases per 100,000 inhabitants), oxyuriasis (69.8 cases per 100,000 inhabitants), and giardiasis (54.9 cases per 100,000 inhabitants). The average annual incidence rate for taeniasis, toxoplasmosis, hydatid disease, strongyloidiasis, ascariasis, and scabies were 0.01, 0.12, 0.93, 1.7, 8.3, and 20.1 cases/100,000 inhabitants, respectively (Table 2).

DISCUSSION

This study investigated the epidemiology of parasitic infections in Palestine and compared the infection rate between the West Bank and Gaza Strip. The study was based on inspecting health records of the Palestinian Ministry of Health, including patients seeking treatment and referred to health centers and hospitals in all districts in the West Bank and Gaza Strip with standard and approved diagnostic methods for each parasitic disease.

Parasitic infections caused by pathogenic parasites are common in many developing countries, primarily in children.[16–19] The existence of these diseases in Palestine is not surprising; most of the cases were reported in the Gaza Strip. Previous reports from Palestine confirmed high levels of infection of intestinal parasites in different regions, especially among school children.[6,9,10,12,13]

The results reported in this study are consistent with other reports about the existence of various parasitic infections in Palestine, especially scabies[20] and intestinal parasites.[9,10,21] Oxyuriasis caused by *E. vermicularis* was the most prevalent infection in Nablus, which is a highly populated district with three crowded refugee camps, where most of the cases were reported. Amebiasis and giardiasis were most prevalent in the Gaza Strip. This might be due to the Gaza War that took place in 2008 between Israel and Palestine. During this war, inhabitants especially in Gaza City were forced to leave their homes and settle in crowded temporary camps, where reporting and surveillance of parasitic diseases were severely affected. Moreover, all services, including primary health care, water and food supplies, sanitation, and waste collection services, were either collapsed or completely stopped. These conditions contributed to the increased number of cases during and after the war in 2008.[22]

In the last 10 years, the total number of infected people in Palestine was 137,106 (92,494 (67%) in Gaza Strip and 44,612 (33%) in the West Bank). This variation between the two separated Palestinian regions is related to many factors, including level of poverty, personal hygiene, availability of clean water, functioning sanitary systems, and availability of electricity, all of which are influenced by the repeated wars and continuous siege on the Gaza Strip. The consequences of these factors on public health are very high: 70% of inhabitants of the Gaza Strip are living below the poverty level in

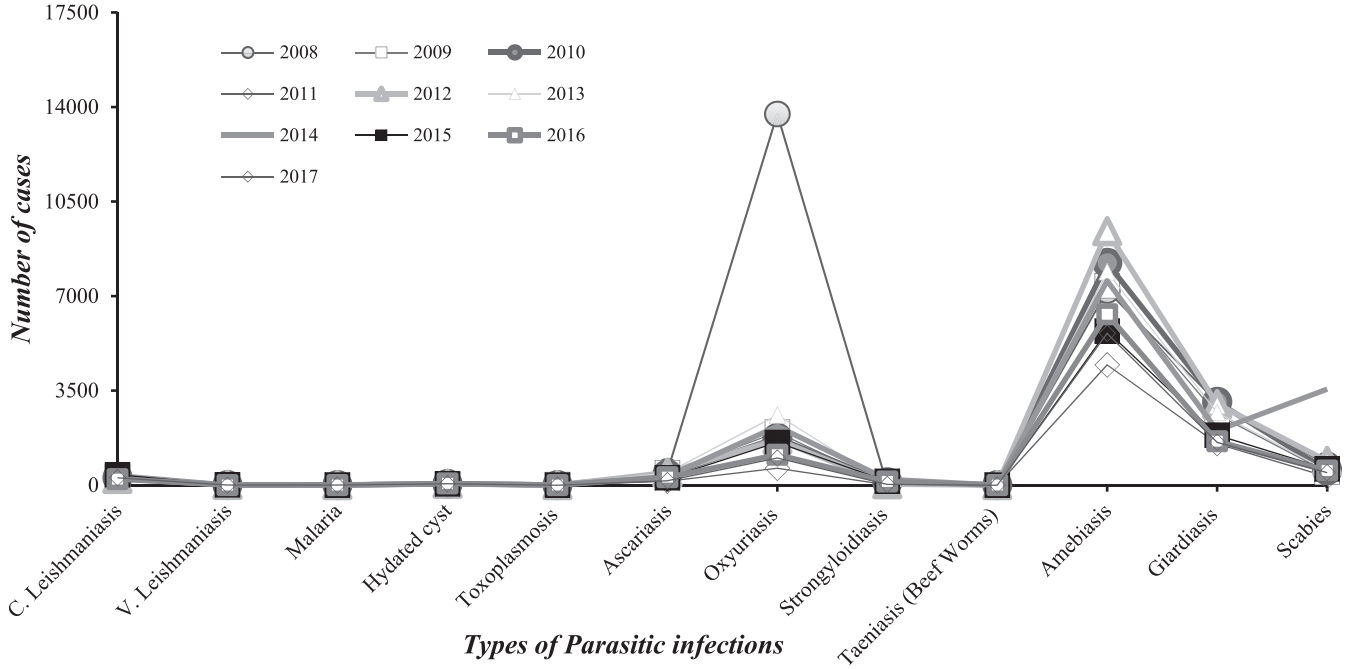

FIGURE 2. Yearly trends of all parasitic infections in Palestine from 2008 to 2017 represented by the number of cases. This figure appears in color at www.ajtmh.org.

TABLE 2
Total number of cases and average annual incidence rate/100,000 inhabitants for each parasitic disease in the West Bank and Gaza Strip districts

	West Bank									
Disease	Hebron	Bethlehem	Jerusalem	Ramallah	Jericho	Nablus	Jenin	Tulkarem	Qalqilia	Salfit
Cutaneous leishmaniasis	228 (3.5)	191 (10.1)	43 (1.1)	87 (2.9)	603 (130.3)	218 (6.2)	462 (16.6)	94 (5.3)	136 (13.1)	107 (15.8)
Visceral leishmaniasis	19 (0.03)	1 (0.05)	–	11 (0.37)	–	2 (0.06)	2 (0.07)	3 (0.18)	–	2 (0.30)
Hydatid disease	283 (4.42)	19 (0.92)	3 (0.08)		1 (0.23)	81 (2.27)	6 (0.21)	1 (0.06)	2 (0.20)	
Toxoplasmosis	3 (0.04)	3 (0.16)	–	–	7 (1.53)	3 (0.09)	–	1 (0.06)	2 (0.19)	8 (1.32)
Ascariasis	–	47 (2.48)	931 (23.10)	7 (0.23)	2 (0.45)	930 (26.30)	1 (0.03)	1 (0.06)	6 (0.65)	6 (0.90)
Oxyuriasis	–	1,843 (93.12)	–	–	94 (20.39)	21,778 (651.1)	231 (7.67)	–	826 (79.52)	1,976 (291.8)
Strongyloidiasis	–	–	–	18 (0.59)	–	648 (17.76)	–	1 (0.06)	–	–
Taeniasis caused by *Taenia saginata*	–	1 (< 0.01)	–	–	–	–	–	–	–	1 (< 0.01)
Amebiasis caused by *Entamoeba histolytica*	–	241 (12.45)	4 (0.11)	42 (1.40)	70 (14.74)	4,204 (120.5)	912 (34.24)	52 (2.84)	111 (11.29)	352 (54.72)
Giardiasis	–	4 (0.20)	–	–	71 (14.8)	168 (4.8)	2 (0.07)	–	11 (1.1)	–
Scabies	170 (2.76)	176 (9.02)	191 (4.84)	387 (12.77)	168 (37.6)	1,182 (33.35)	626 (22.94)	374 (21.86)	167 (16.69)	547 (87.76)
Total	703	2,529	1,173	554	1,016	29,214	2,242	527	1,261	2,999

	Gaza Strip								
Disease	Tubas	Total West Bank	North Gaza	Gaza City	Deir Al Balah	Khan Younis	Rafah	Total Gaza Strip	Total Palestine
Cutaneous leishmaniasis	503 (89.4)	2,672 (10.2)	–	–	–	–	–	–	2,672 (6.3)
Visceral leishmaniasis	–	40 (0.15)	–	–	–	–	–	–	40 (0.09)
Hydatid disease	5 (0.91)	401 (1.52)	–	–	–	–	–	–	401 (0.93)
Toxoplasmosis	–	27 (0.11)	–	20 (0.39)	–	–	–	20 (0.14)	47 (0.12)
Ascariasis	16 (2.85)	1,947 (7.44)	546 (17.77)	430 (7.84)	112 (4.93)	206 (7.00)	224 (11.82)	1,518 (9.65)	3,465 (8.26)
Oxyuriasis	1,176 (205.5)	27,924 (111.8)	53 (1.65)	138 (2.45)	15 (0.63)	63 (1.99)	52 (2.64)	321 (1.97)	28,245 (69.8)
Strongyloidiasis	–	667 (2.47)	17 (0.56)	17 (0.32)	1 (0.04)	19 (0.64)	8 (0.42)	62 (0.40)	729 (1.66)
Taeniasis caused by *Taenia saginata*	–	2 (< 0.01)	–	–	–	–	–	–	2(< 0.01)
Amebiasis caused by *Entamoeba histolytica*	650 (113.8)	6,638 (25.91)	10,408 (329)	30,437 (532.4)	5,126 (220.1)	8,595 (286)	8,567 (426.9)	63,133 (348.1)	69,771 (164.6)
Giardiasis	5 (0.88)	261 (0.99)	4,523 (144.6)	7,408 (131.5)	2,165 (94.7)	2,954 (92.9)	5,751 (288.4)	22,801 (140.5)	23,062 (54.9)
Scabies	39 (7.00)	4,027 (15.75)	775 (23.17)	1,788 (29.4)	698 (28.66)	702 (20.88)	675 (31.7)	4,638 (26.7)	8,665 (20.12)
Total	2,394	44,612	16,329	40,231	8,118	12,539	15,277	92,494	137,106

Numbers between brackets are the annual incidence rate per 100,000 inhabitants.

highly crowded areas. More than 90% of people living in the Gaza Strip do not have access to clean drinking water, and most natural water resources are contaminated. However, Palestinians living in the West Bank have better access to health services, clean drinking water, and functioning sanitary sewer systems which contribute to lower disease prevalence.

The number of reported toxoplasmosis cases was surprisingly very low in both the West Bank and Gaza Strip (27 and 20 cases). Serological diagnosis of toxoplasmosis during pregnancy is not mandatory and carried out on request. Two studies on seroprevalence of toxoplasmosis among Palestinian women who are pregnant or received an abortion in Hebron in the West Bank[23] and Gaza City[24] in Gaza Strip showed high seroprevalence and recommended routine IgG and IgM tests in early stages of pregnancy to reduce the effects of the disease on mothers and babies. Health awareness programs were routinely conducted by the Child and Mother Health Unit at the Palestinian Ministry of Health to advise pregnant women to avoid contact with domestic cats. On the other hand, scabies infection was highly prevalent in both the West Bank and Gaza Strip. Recent studies on epidemiology of scabies in Palestine have identified several risk factors associated with the disease. These include crowding, poor hygiene, and low socioeconomic status.[20,25]

Leishmaniasis is endemic in the West Bank, but no cases were reported in the Gaza Strip. Cutaneous leishmaniasis infection in the West Bank comprised about 1.9% of the total parasitic infections in Palestine, with *Leishmania tropica* and *Leishmania major* as the main causative agents. Leishmaniasis is prevalent in regions with high agricultural activities such as Jericho, Jenin, and Tubas.[26] Visceral leishmaniasis is caused by *Leishmania infantum* which is prevalent in the western parts of the West Bank, extending to central Israel.[27]

No leishmaniasis cases were reported in the Gaza Strip, probably because of unfavorable conditions for the sand fly vectors or the *Leishmania* parasites, although cutaneous leishmaniasis is endemic in the nearby Sinai and Negev deserts.[28]

Malaria was completely eradicated in Palestine between 1922 and 1925.[29] The seven reported cases in this study were imported, and patients reported traveling to malaria-endemic areas before their infection. Thus, local transmission of the parasite is very unlikely in Palestine.

Strongyloidiasis and ascariasis were reported in both the Gaza Strip and West Bank, with the highest numbers reported in Nablus. A household survey in the Gaza Strip documented that 56% of examined individuals were infected with *Ascaris lumbricoides* and 15.5% with *S. stercoralis*. A similar infection trend was found in the northern districts of the West Bank. Both infections were associated with age, level of education, and socioeconomic conditions.[12,30]

Limitations were identified in this study. First, data were collected from annual health reports of the Palestinian Ministry of Health, which could have underestimated the prevalence

because of underreporting and limitations in laboratory diagnosis. Second, many of the diagnoses were based on voluntary reporting by health departments, likely leading to underestimation. Third, information on seasonality of the infections was not evaluated. Fourth, sociodemographic information could not be collected.

Further research is needed to guide public health and clinical recommendations to control parasitic infections. Community health education campaigns directed to the public and health care professionals concerning preventive measures would help raise awareness about parasitic infections. Local health authorities should provide routine observation of food handlers as well as the level of personal hygiene of employees in restaurants, schools, and hospitals. Because of frequent electricity interruptions in the Gaza Strip, untreated sewage is pumped directly to the sea or open pools, directly contributing to the high number of intestinal parasite infections.

Prevention and control measures should be directed to increase awareness toward these diseases. Meanwhile, other parasitic diseases exist in Palestine but were not reported by the Palestinian Ministry of Health. Therefore, current surveillance programs should be thoroughly revised and evaluated.

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